Multimedia Processing and Systems

8 May, 2018

4th Year

Introduction

- What is Multimedia?
- What is Multimedia Processing?
- Goals of Multimedia Processing
- What is Multimedia Systems?
- Multimedia Applications

Introduction

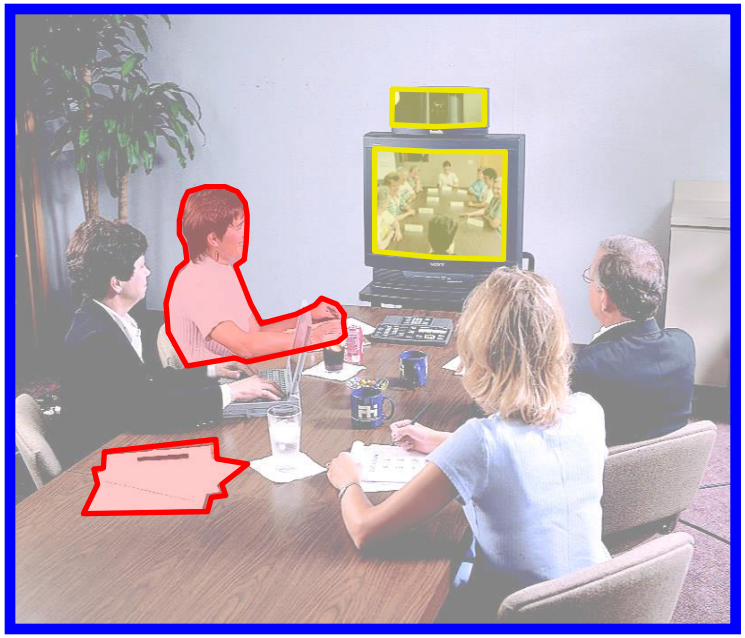
- **Multimedia consists of:**
  - **multimedia data**
  - **interaction set**

- **Multimedia data:**
  - **multi-source, multi-type, multi-format**

- **Interaction set:**
  - **without interactions between multimedia components, multimedia is merely a collection of data**

Introduction

Example: Augmented reality conference



real objects

virtual objects

real speech

} ***Mutimedia Data Components***

Complex interactions between components in the scene make virtual components seem more realistic

Introduction

What Is Multimedia Processing?

- Multimedia processing
  - apply signal processing tools to multimedia data to enable:
    - » **representation**
    - » **interpretation**
    - » **encoding**
    - » **decoding**

Introduction

Goals of multimedia processing:

- Effective & efficient
  - access
  - manipulation
  - exchange
  - storage

of multimedia content

Multimedia Data: Input and Format

Text and Static Data

- Source: keyboard, speech input, optical character recognition, data stored on disk.

- Stored and input character

- Storage of text is 1 byte per char / more bytes for Unicode.
  - For other forms of data (e.g. Spreadsheet files).
  - May store format as text (with formatting) others may use binary encoding.
- Format: Raw text or formatted text e.g HTML, Rich Text Format (RTF), Word or a program language source (C, Pascal, etc.

Multimedia Data: Input and Format

Graphics

- Format: constructed by the composition of primitive objects such as lines, polygons, circles, curves and arcs.

- Input: Graphics are usually generated by a graphics editor program (e.g. Illustrator). Graphics are usually editable.

- Graphics input devices: keyboard (for text and cursor control), mouse, trackball or graphics tablet.
- Graphics standards : OpenGL, PHIGS, GKS

- Graphics files usually store the primitive assembly

- Do not take up a very high storage overhead

Multimedia Data: Input and Format

Images

- Still pictures which (uncompressed) are represented as a bitmap (a grid of pixels).
- Input: digitally scanned photographs/pictures or direct from a digital camera.
- Input: May also be generated by programs “similar” to graphics, or animation programs.
- Stored at 1 bit per pixel (Black and White), 8 Bits per pixel (Grey Scale, Colour Map) or 24 Bits per pixel (True Colour)
- Size: a 512x512 Grey scale image takes up 1/4 MB, a 512x512
- 24 bit image takes 3/4 MB with no compression.
- **Compression is commonly applied with the increased size of the images.**

Multimedia Data: Input and Format

Audio

- Audio signals are continuous analog signals
- Input: microphones and then digitized and stored
- CD Quality Audio requires 16-bit sampling at 44.1 KHz
- Even higher audiophile rates (e.g. 24-bit, 96 KHz)
- 1 Minute of Mono CD quality (uncompressed) audio requires 5 MB.
- 1 Minute of Stereo CD quality (uncompressed) audio requires 10 MB.
- Usually **compressed (E.g. MP3, AAC, Flac, Ogg Vorbis)**

Multimedia Data: Input and Format

Video

- Input: Analog Video is usually captured by a video camera and then digitized.
- There are a variety of video (analog and digital) formats
- Raw video can be regarded as being a series of single images
- There are typically 25, 30 or 50 frames per second
- Typical PAL digital video (720 576 pixels per colour frame)
- High Definition video on Blu-ray (up to 19201080 = 2 Megapixels per frame) Digital video clearly needs to be compressed for most times

Multimedia Data Compression

- How can we compress data?

- Lossy vs Lossless :
  - Lossless : Ideal (e.g. zip, unix compress) not good enough for MM data!
  - Lossy:Throw away nonessential (perceptually less relevant) parts of the data stream FILTER the data somehow. Examples: MP3, JPEG, MPEG Video

Video Compression

- Raw rate:
  - images: 24 or 30 per second.
  - Size: 1024 x 1024 = 1 M pixels
  - pixel encoding 24 bit
  - Rate: 576 or 900 Mbps !!!

- Compression schemes (many):
  - MPEG 1 (1.5 Mbps) CD quality
  - MPEG 2 (3-6 Mbps) DVD quality
  - Motion JPEG
  - H.261 (for ISDN)

- Variable rate compression

What is multimedia system?

- A Multimedia System is a system capable of processing multimedia data and applications.

- It is characterized by the processing, storage, generation, manipulation and interpretation of the Multimedia information.

Multimedia System Characteristics

A **Multimedia system has four basic characteristics:**

- Multimedia systems must be computer controlled.
- Multimedia systems are integrated.
- The information they handle must be represented digitally.
- The interface to the final presentation of media is usually interactive.

Challenges for Multimedia Systems

- **Distributed Networks**

- **Temporal relationship between data**
  - Render different data at same time — continuously.
  - Sequencing within the media playing frames in correct order/time frame in video.

- **Synchronization** — inter-media scheduling e.g. Video and Audio conversation**.**

Key Issues for Multimedia Systems

- The key issues multimedia systems need to deal with include:

  -How to represent and store temporal information

  -How to strictly maintain the temporal relationships on play

Key Issues for Multimedia Systems

- back/retrieval
- What process are involved
- Data has to be represented digitally
- Conversion, Sampling etc.
- Large Data Requirements — bandwidth, storage, Data compression is usually mandatory.

Desirable Features for a Multimedia System

- According to the mentioned challenges, the following feature is required for a Multimedia System:

  -Very High Processing Power — needed to deal with large data processing and real time delivery of media.

Multimedia System: Required Features

- Special **Hardware/Software** needed
- **Data Representations** — File Formats that support multimedia should be easy to handle yet allow for compression/decompression in real-time
- **Efficient and High I/O** —input and output to the file subsystem needs to be efficient and fast. Needs to allow for real-time recording as well as playback of data
- Special **Operating System** —to allow access to file system and process data efficiently and quickly.
- **Storage and Memory** — large storage units.
- **Network Support** — Client-server systems -Software Tools — user friendly tools needed to handle media, design and develop applications to deliver media.

Multimedia System: Components

Required Hardware and Software components for a multimedia system:

- **Capture devices**
- **Video** Camera, Video Recorder, Audio Microphone, Keyboards, mice, graphics tablets.
- **Storage Devices** — Hard disks, CD-ROMs, DVD-ROM, etc.
- **Communication Networks** — Local Networks, Intranets, Internet, Multimedia or other special high speed networks
- **Computer Systems** — Multimedia Desktop machines, Workstations.
- **Display Devices**, quality speakers, HDTV. monitors, Colour printers etc

Impact of Multimedia

- Users (society) demand
  - increased mobility
  - ease-of-use
  - personal customization
  - device flexibility
  - high level of collaboration with peers
- Devices mutate and become
  - multi-functional, not specialized
  - effortlessly portable, not stationary
  - ubiquitously networked, not isolated

Impact of Multimedia

- Multi-functional devices must
  - browse internet
  - entertain
  - be easy-to-use
  - ***facilitate many types of workflow***
  - ***manage user's time***
- Customization
  - personalization (themes, preferences)
- Networked
  - capable of connecting to many different networks

Impact of Multimedia

Convergence

Technologies which were totally unrelated 10 years ago are now unified under the concept of multimedia

Impact of Multimedia

- **Example: Cellular Phones**

Primary Consumer Use:

- ***Wireless Telephony***

CONVERGED USES

- ***personal organizer***
- ***INTERNET BROWSER/EMAIL***
- ***Entertainment (Mp3, Radio)***

- ***PAGER/MESSAGING (SMS)***
- ***VIDEO/STILL CAMERA***

Overall Impact of Multimedia

- Demands
  - functionality
  - consumption of many media types
  - connectivity
  - portability, etc.

- Result
  - highly complex devices
  - push towards dense circuitry
  - multimedia devices become ubiquitous
  - devices generate multimedia data (including images, video, audio)

Multimedia Application Classes

- Typically:
  - sensitive to delay, but
  - can tolerate packet loss

- Data contains audio and video content ("continuous media"), three classes of applications:
  - Streaming
  - Unidirectional Real-Time
  - Interactive Real-Time

Application Classes

- **Streaming**
  - Clients request audio/video files from servers and pipeline reception over the network and display
  - Interactive: user can control operation (similar to VCR: pause, resume, fast forward, rewind, etc.)
  - Delay: from client request until display start can be 1 to 10 seconds

Application Classes

- **Unidirectional Real-Time:**
  - similar to existing TV and radio stations, but delivery on the network
  - Non-interactive, just listen/view

- **Interactive Real-Time :**
  - Phone conversation or video conference
  - More stringent delay requirement than Streaming and Unidirectional because of real-time nature
  - Video: < 150 msec acceptable
  - Audio: < 150 msec good, <400 msec acceptable

Multimedia Applications

GPS Navigation

Scalable Video Streaming

Multimedia Applications

Tele-presence

E-commerce

Cellular

Multimedia Applications

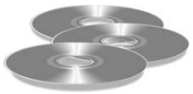
- ***More Specific Examples***
  - ***MPEG-4, 7, 21***
  - ***JPEG-2000***
  - ***MP3 & PERCEPTUAL CODING***
  - ***Multimedia Storage***
  - ***Video-on-demand***
  - ***Digital Cinema***
  - ***Authentication***
- ***Multimedia Application Goals***
  - ***improve interpersonal communication***
  - ***promote understanding of ideas***
  - ***allow interactivity with media***
  - ***increase accessibility to data***

Content Based Image Retrieval (CBIR)

EXAMPLE: GENERAL PHOTOGRAPHY

- ***Polaroid filed for bankruptcy***
  - ***has digital killed film? if so, why?***

- ***SNAPSHOT PREVIEWS***
- ***MEMORY REUSABLE***
- ***printer technology***



- ***EASY SHARING VIA INTERNET***
- ***CHEAP & DENSE STORAGE***
- ***EFFECTS & PROCESSING***

- ***RESULT: DIGITAL MEDIA FLOOD***
  - ***HOW DO WE COPE, TRACK, ORGANIZE IT ALL?***

CBIR: Motivation

- ***Device Function Convergence***
  - ***Data Rapidly Generated By Many Devices***
  - ***Internet Acts As Global Transport***
  - ***Data Consumed By Devices On Demand***

- ***Multimedia Data Needs To Be***
  - ***Efficiently Stored***
  - ***Indexed Accurately***
  - ***Easily Retrieved***

CBIR: IS…

- Part of Multimedia Indexing
  - Images (2-d Space-dependent Signals)
  - Video (Time-varying Image Set)
  - Audio (1-d Time-dependent Signals)
  - TEXT (E.G. Book Index, Search Engines)
- Computer based
- Highly automated
- Difficult to do properly

CBIR Application Areas

- ***MEDICAL IMAGING***

- ***ART/CULTURAL HERITAGE***

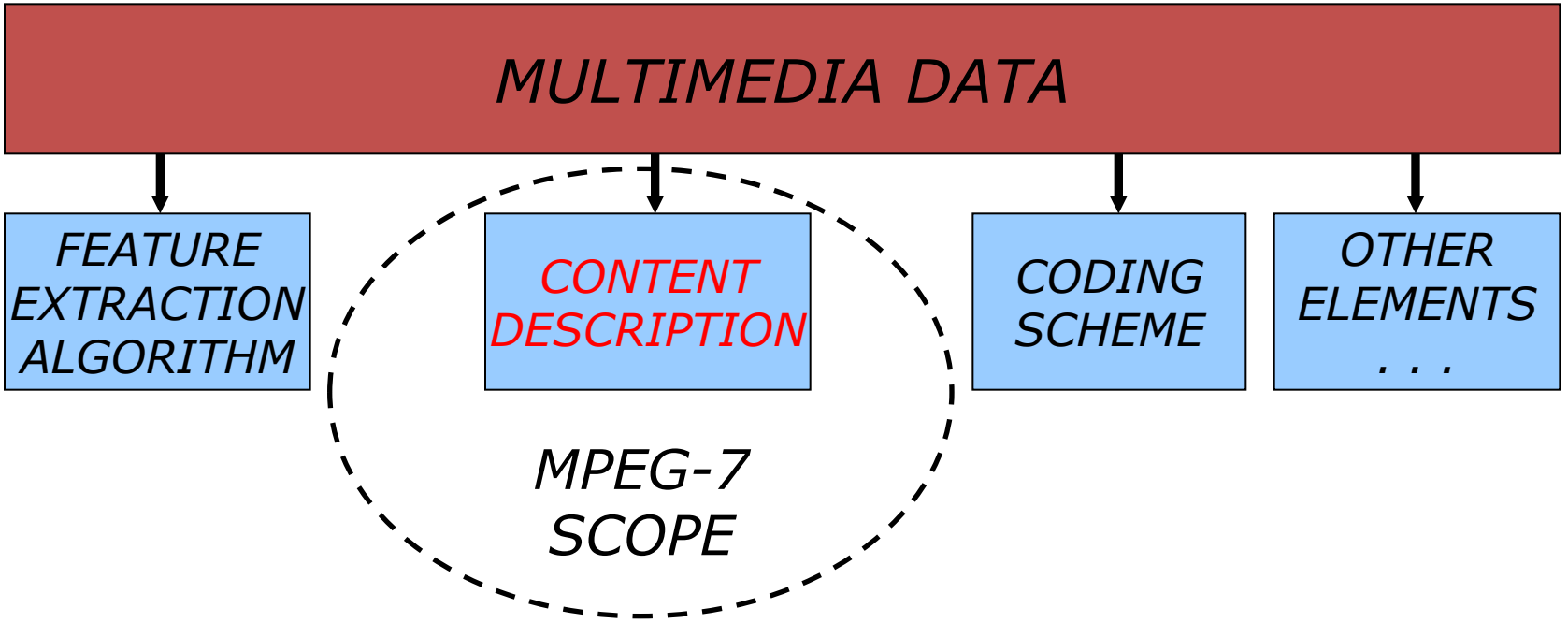
- ***DESIGN/VISUAL ARTS***

- ***ENTERTAINMENT (FILM, TV)***

- ***INDUSTRY (LOGO MANAGEMENT)***

- ***GOVERNMENT (E.G. MUGSHOTS)***

MPEG-7: SCOPE


MULTIMEDIA DATA
FEATURE EXTRACTION ALGORITHM
CONTENT DESCRIPTION
CODING SCHEME
OTHER ELEMENTS . . .
MPEG-7 SCOPE

CBIR: SUMMARY

- ***Started from multimedia flood***
- ***Text too simple and laborious***
- ***Systems work decently in vitro***
  - ***query by shape, color, texture, example***
- ***Shortcomings***
  - ***need relevance feedback & perceptual***
  - ***hybrid queries difficult to create***
  - ***semantic gap needs to be bridged***
- ***Motion pictures expert group (MPEG-7): important development***

Summary

- **Multimedia processing**
  - results from multimedia explosion
  - users demanding more from devices
  - devices are converging
- **Content based image retrieval**
  - necessary to track visual sea of data
  - good capabilities, but w/ shortcomings
  - perceptual/subjective issues
  - relevance feedback
  - distributed concepts becoming critical
- **MPEG-7**
  - aimed at standardizing descriptions
  - radically different than previous mpegs
  - DDL is an extension of xml schema
  - applicable to all multimedia data

Any Questions!!